Chapter 3

Affected Environment

THIS PAGE INTENTIONALLY LEFT BLANK

3.1 Introduction

Chapter 3 presents the existing conditions of resources that the three alternatives (described in Chapter 2) could affect (either adversely or beneficially). The resources discussed below are referred to as "impact topics" because they are resources that the National Park Service (NPS) has identified as potentially receiving impacts from the alternatives analyzed in this DEIS (*see* Chapter 1, Section 1.9).

The impact topics are:
(1) NPS Natural Resource Management (*see* Section 3.2);
(2) NPS Visitor Experience and Enjoyment (*see* Section 3.3);
(3a) Social Resources: The Research Community (*see* Section 3.4); and
(3b) Social Resources: NPS Administrative Operations (*see* Section 3.5.)

Chapter 3 does not describe possible impacts or effects on the impact topics. Instead, Chapter 4 discusses the potential impacts or effects.

The impact topics discussed in this chapter came both from public comments (during scoping, as summarized in Chapter 1, Section 1.8 and Appendix D) and from internal NPS comments and questions. Selection of major impact topics also took into account federal laws, executive orders, regulations, and NPS policies (as described in Section 1.2.4).

The impact topics discussed in this chapter do not include many of the more traditional impact topics frequently seen in EISs or EAs, for instance, soils, water quality, wildlife, cultural resources, or economic benefits to communities. The NPS judged that such traditional impact topics were not appropriate because this DEIS is a programmatic document and is therefore not site-specific in its resource discussions. Instead, the alternatives (as described in Chapter 2) include broad, servicewide management actions. Such actions do not have site-specific impacts, so Chapter 3 does not include a profile of site-specific park resources.

If Alternative B (Implement Benefits-Sharing) is selected, then NEPA review (EIS, EA, or CE) of specific benefits-sharing agreements that might be established by individual parks in the future can be tiered from this programmatic EIS. If an individual park proposed site-specific resource management projects using non-monetary or monetary benefits generated by a benefits-sharing program, such projects would receive a separate environmental review for potential project-specific impacts in compliance with NEPA.

3.2 NPS Natural Resource Management

Sound management of park resources is the central NPS mission. This section describes current NPS natural resource management, which might experience different impacts from the three alternatives analyzed in this DEIS.

A thorough understanding of natural resources is essential to the effective management and long-term preservation of national parks, and requires a sound scientific basis.[1] Therefore,

scientific research is a vital part of resource stewardship.[2] The nexus between natural resource management and science is described below. This section describes park-related scientific research in qualitative terms.[3]

This section also describes two financial metrics used in Chapter 4 to evaluate potential impacts of monetary benefits that could be generated under Alternative B (Implement Benefits-Sharing). These metrics are the funding needed for natural resource management operations as described in NPS Business Plans (*see* this chapter, section 3.2.2.1) and the FY2004 Congressional appropriation (funding) for the NPS Natural Resource Challenge. Chapter 4 analyzes the potential impacts of the alternatives by comparing these quantitative metrics to available information about the income derived by academic and federal research institutions from licensing intermediate research results to other institutions for further research, development, and eventual commercialization.

3.2.1 Natural Resource Management and Science

The importance of scientific research to natural resource management has been emphasized by Congress in the National Parks Omnibus Management Act of 1998, by the Council on Environmental Quality, and by the NPS's own *Management Policies 2001*. The NPS encourages both "science for parks" and "parks for science," consistent with NPOMA's declaration that scientific study is an authorized use of parks.

Years ago, park managers could protect park resources primarily by foiling poachers and vandals. Modern resource protection is not as simple. For example, air pollution from densely populated Asia reportedly reaches the U.S. Rocky Mountains in just 17 days.[4] In addition, many scientists believe that the introduction and establishment of exotic invasive species from other continents is the single greatest threat to park preservation. Clearly, park protection in the twenty-first century is far more complex than it was with the establishment of the first park in 1872.

The National Parks Omnibus Management Act of 1998

In 1998, Congress enacted the National Parks Omnibus Management Act (NPOMA), which directed the NPS to manage park resources through the application of science and scientific principles. NPOMA requires the NPS to "conduct scientific study in the National Park System and to use the information gathered for management purposes" (i.e., "science for parks," described in more detail in Section 3.2.1.1), and to "encourage others to use the National Park System for study to the benefit of park management as well as broader scientific value" (i.e., "parks for science," described in more detail in Section 3.2.1.2).

The Council on Environmental Quality (CEQ)

In managing parks, the NPS responds to recommendations the CEQ made in 1993 for improving consideration of the reasonably foreseeable environmental effects of proposed federal actions, including addressing the importance of scientific research and information sharing (particularly in connection with management of biological resources). They include:

- Actively seek relevant scientific information from sources both within and outside government agencies;

- Encourage and participate in efforts to improve communication, cooperation, and collaboration between and among governmental and non-governmental entities;
- Improve the availability of information on the status and distribution of biodiversity, and on techniques for managing and restoring it; and
- Expand the information base on which biodiversity analyses and management decisions are based.[5]

These recommendations emphasize the importance of improving access to relevant scientific information, and improving incorporation of related research activities and results in biological resource management activities.

NPS Management Policies 2001

NPS Management Policies 2001 states that NPS natural resources will be managed to preserve fundamental physical and biological processes, as well as individual species, features, and plant and animal communities. The policies provide general principles for managing biological resources as follows:[6]

- Preserving and restoring the natural abundances, diversities, dynamics, distributions, habitats, and behaviors of native plant and animal populations and the communities and ecosystems in which they occur;
- Restoring native plant and animal populations in parks when they have been extirpated by past human-caused actions; and
- Minimizing human impacts on native plants, animals, populations, communities, and ecosystems, and the processes that sustain them.

Examples of NPS natural resource management policies that are particularly reliant on science include the following:

Planning for Natural Resource Management

- Planning for park operations, development, and management activities that might affect natural resources will be guided by high-quality, scientifically acceptable information, data, and impact assessment.

Evaluating Impacts on Natural Resources

- This evaluation must include the application of scholarly, scientific, and technical information in the planning, evaluation, and decision-making processes.

Plant and Animal Population Management

- Data will be developed, through monitoring, for use in plant and animal management programs.
- Information about species life cycles, ranges, and population dynamics will be presented in park interpretive programs for use in increasing public awareness of management needs for all species, both resident and migrant, that occur in parks.
- The results of managing plant and animal populations will be assessed by conducting follow-up monitoring or other studies to determine the impacts of the management methods on non-targeted, as well as targeted, components of the ecosystem.
- Scientifically valid resource information obtained through consultation with

technical experts, literature review, inventory, monitoring, or research will be used to evaluate the identified need for population management.

Specific natural resource management activities that occur in individual parks are described in greater detail in management plans specific to each park.[7] The impact of the alternatives on the ability of parks to adhere to these management principles is analyzed in Chapter 4.

3.2.1.1 Science for parks

To undertake the first of the responsibilities identified by NPOMA—"science for parks"—more directly, the NPS conducts cooperative research with federal and non-federal public and private agencies, organizations, individuals, and other entities to increase scientific understanding of NPS natural resources.

Virtually all parks have challenges to their conservation mandate that only good science—new knowledge relevant to NPS resource management needs—can define with sufficient detail to allow park managers to meet those challenges. The NPS conducts cooperative research with federal and non-federal public and private agencies, organizations, individuals, and other entities to increase scientific understanding of NPS natural resources. Examples of NPS science projects and partnerships that are designed to meet natural resource management needs include the following:

- The NPS has implemented an Inventory and Monitoring program at 270 parks organized into 32 networks based on the biogeographical similarities of their parks (pursuant to NPOMA § 5934).
- The NPS Alaska Region is focusing on improving the scientific understanding of parks through partnerships with universities and research institutions, as well as state and federal agencies.[8]
- The Northeast Coastal and Barrier Network has created a Technical Steering Committee of highly qualified scientists and park staff charged with assisting and advising the network with the planning and implementation of their long-term monitoring program.[9]
- When monitoring of Channel Islands NP's fox population indicated the foxes were in grave danger of becoming extinct, this information was made available in time for park managers to initiate a captive-breeding program to stabilize the population. Without the data, the island fox population on at least one of the islands might have been completely lost before the severity of the decline was apparent.[10]
- In 2001, the NPS inaugurated a new network of Research Learning Centers, where scientists, park managers, and the public come together to advance learning about park natural resources. Thirteen of the 32 Learning Centers planned for the NPS were funded by 2002.
- Additional partnerships between the U.S. Geological Survey (USGS) and the NPS, for example the NPS/USGS water quality partnerships in 56 parks, provide information that meets specific park management needs.
- Other NPS/USGS partnerships, such as the volcano observatories in Yellowstone and Hawaii Volcanoes national parks, perform long-term monitoring of park hazards as scientists seek to understand the underlying geologic processes that

fundamentally affect the ecosystems of those parks.

Actions taken under the alternatives could affect the availability of knowledge and tools used to perform these program activities.

Sound science can come from many sources. While the NPS has a modest internal scientific function, and regularly draws on that source, the NPS cannot afford to fund all of the research required for the problem-solving needs of the National Park System (*see* Section 3.2.2).

Successful park resource stewardship requires knowledge about the presence and locations of life forms. The NPS has statutory direction to inventory park biodiversity, and over the long term the contribution of personal services toward this effort by non-NPS scientists and experts has been significant. Much of the project funding has come from non-NPS sources, as well. Although these scientists generally provide the largest single input of new knowledge parks receive, their research objectives are often not based primarily on NPS natural resource management goals, and so park management may be left with gaps in needed information.

In a specific example of the contribution that independent researchers make to the NPS, the majority of new species currently being added to park biodiversity rosters are microbes, but the NPS does not employ permanent, full-time microbiologists to conduct microbial research and funds little research on microbes. The NPS has largely depended upon independent researchers working within the parks for this type of information, and not all researchers systematically share such knowledge with the NPS; nor are all parks positioned to take advantage of such information.

In short, the NPS needs independent research to help develop the scientific information needed to meet its mission to protect the parks. Section 3.4.1 describes the reports made by independent researchers to park units about the knowledge gained during their research.

3.2.1.2 Parks for science

The NPS encourages a broad range of non-NPS research projects addressing the second scientific responsibility established by NPOMA: "parks for science."[11] Universities, government laboratories and agencies, industry, and consulting firms make up the bulk of scientific expertise found in the U.S., and most research in parks is undertaken by non-NPS scientists (*see* this chapter, Section 3.4).

These non-NPS scientists conduct a substantial amount of research in parks that contributes to the body of scientific knowledge, but does not necessarily present information relevant to recognized resource management concerns, or solutions to resource management problems. Nevertheless, the study topics and results strengthen and broaden knowledge about park resources and ecosystems, building a cumulative knowledge base essential to park resource managers. That knowledge may also contribute information to a future management problem or contribute to a park's interpretive or educational mission.

NPS guidelines that standardize the management of research specimen collection and related scientific activities throughout the National Park System were updated in January 2001, after the NPS requested and evaluated public comments and review (*see also* Chapter 1, Section 1.6).

3.2.2 Quantitative Measurements Used for Comparison of the Alternatives

This section describes two financial metrics used in Chapter 4 to evaluate potential impacts of monetary benefits that could be generated under Alternative B (Implement Benefits-Sharing). The two financial metrics are (1) funding available for natural resource management operations as described in park Business Plans and (2) the FY2004 Congressional appropriation (funding) for the NPS Natural Resource Challenge. Chapter 4 analyzes the potential impacts of the alternatives by comparing these quantitative metrics to available information about the benefits derived by academic and federal research institutions from licensing intermediate research results to other institutions for further research, development, and eventual commercialization.

3.2.2.1 NPS Business Plans

The NPS Business Plan Initiative (BPI) is a public–private partnership between the National Park Service, the National Parks Conservation Association, and a consortium of philanthropic organizations that measures the operational needs of national parks in business terms.[12] All parks developing Business Plans applied a common methodology developed by BPI staff and graduate students from the nation's top business and public policy schools.[13] The BPI has worked with park units of all types from all NPS regions. These units vary in total budget size, visitation, and acreage.

NPS Business Plans provide a detailed picture of funding for park operations. By July 2003, 48 parks had completed Business Plans. Each plan included a summary of current funding for park natural resource management operations. Within this group, 44 parks had a history of hosting independent research projects. Those 44 parks encompass 50% of servicewide acreage, and serve, in this DEIS, to illustrate the state of natural resource management servicewide. Their funding levels are used in Chapter 4's impact analysis as a metric to

Figure 3.2.2.1. Natural Resource Management Operations Funding Levels

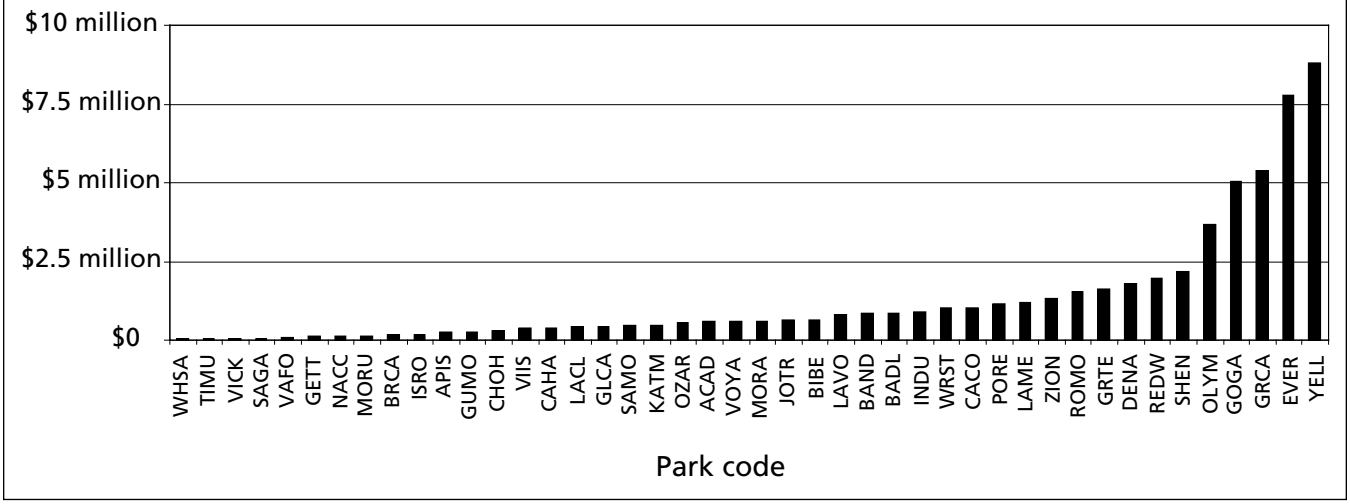

Figure 3.2.2.1. The NPS Business Plan Initiative identified funding levels for natural resource management operations.

evaluate the potential impacts of monetary benefits that could be generated under the preferred alternative.

3.2.2.2 The Natural Resource Challenge

In 1999, the NPS introduced the Natural Resource Challenge (NRC) as its "action plan for preserving natural resources," with the goal of utilizing high-quality science to improve management of park natural resources.[14] This multi-year action plan is a large and complex conglomeration of programs and activities, organized around three central themes or categories:

- Complete inventories and monitor resources (science for parks),[15]
- Eliminate the most critical resource problems, and
- Attract scientists and good science (parks for science).

In 2004, the NRC program reported total funding of approximately $73 million for programs supported by the NRC.[16]

3.3 NPS Visitor Experience and Enjoyment

Visitors are a primary consideration for park managers and employees. As such, visitors' current and future experiences and enjoyment are important topics as the NPS analyzes the impacts from the three alternatives in this DEIS.

The alternatives in this DEIS could affect visitor experience and enjoyment in two ways. First, visitors could be affected by changes to natural resources through the alternatives' impact on natural resource management, including the impact of interpretive services designed to specifically meet natural resource management goals. Second, visitors could be affected by changes in interpretation through potential impacts on the scientific information and assistance available for use in NPS interpretive services.

The availability of "science for parks" can affect the quality of interpretation and therefore visitor experience and enjoyment of parks. This section describes interpretation's use of scientific research. Chapter 4 analyzes potential impacts of the alternatives by describing how the alternatives might affect the science used specifically for interpretive services.

3.3.1 Visitors and Natural Resources

Natural resources are essential to the quality of many visitors' experience and enjoyment of the parks. An understanding of natural resources enhances visitor experience, and is valued by visitors. Interpretation can affect visitor behavior in ways that improve a park's ability to reach natural resource management goals. Accurate information is essential to natural resource interpretation and is dependent on the available scientific information about natural resources in national parks.

In 2001, the National Park Service Comprehensive Survey of the American Public found that 59% of respondents who had visited a national park stated that the main reason they visited national parks was for activities related to the condition of park natural resources, such as

sightseeing, day hiking, wildlife viewing, nature photography, and other activities that allow them to experience and enjoy natural resources. Eighty-four percent of respondents who had visited a national park reported that they went sightseeing while visiting parks, and nearly half (47%) reported that they went day-hiking. These figures suggest that the condition of park natural resources is integral to visitor enjoyment.

3.3.2 NPS Interpretive Services

Visitor experience is heightened when it progresses from enjoyment to an understanding of the reasons for a park's existence, and the significance of its resources. Interpretive materials and programs describe the significance of a park's resources and help people make connections to these resources. Interpretation facilitates a connection between the interests of the visitor and the meanings found in natural resources.

To enhance and supplement visitor experience, the NPS provides information and interpretive experiences in many different formats (*see* figure 3.3.2). These include written materials such as newspapers and books; indoor and outdoor exhibits; and opportunities to spend time with ranger interpreters. Thirty-three percent of all visitors who enter the parks experience at least the exhibits contained in visitor centers, and many more experience other exhibits. In 2004, park interpreters provided both structured and informal programs such as walks, talks, campfire programs, living history performances, and school programs, contacting visitors more than 148 million times.[17] The NPS's official web site was accessed more than 124 million times in 2002.[18]

Figure 3.3.2. NPS Servicewide Interpretive Visitor Contacts, FY2004

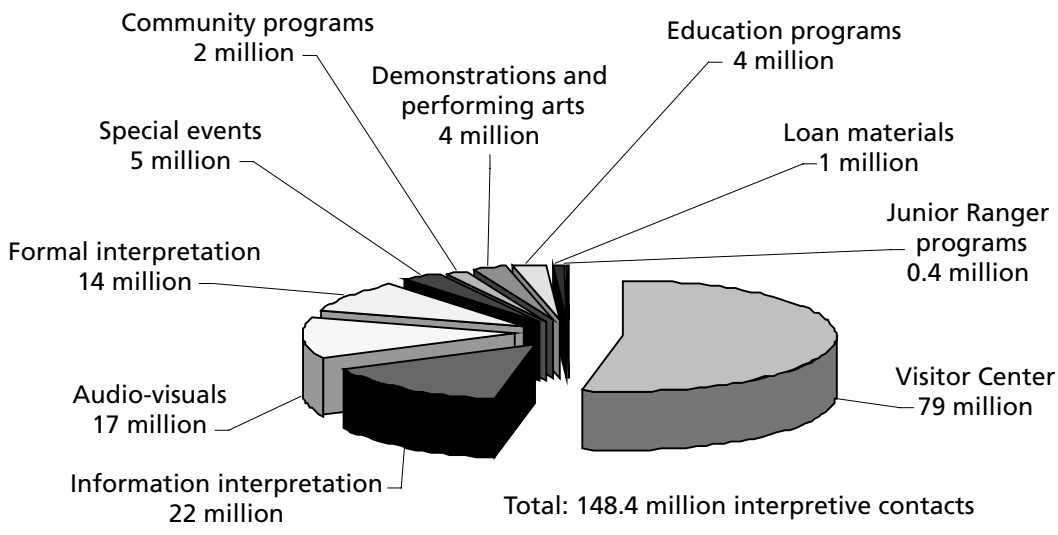

Figure 3.3.2. Millions of park visitors experienced NPS interpretive services in 2004.

3.3.3 Interpretation for Natural Resource Management

In parks where visitor behavior can impact natural resources, visitor education programs are a major way to cultivate positive visitor behavior.[19] This type of targeted resource protection interpretation requires scientifically accurate information about the resources of concern and the way people can affect those resources.

Studies have found that visitor respect for—and willingness to comply with—NPS policies and regulations designed to protect natural resources increases when information that explains the connection between the policy and its purpose is clearly developed and disseminated. In this way, interpretation and visitor education play important roles in minimizing potential conflicts and other adverse impacts on NPS natural resources and values that can result from visitor behavior while in the parks.[20]

Park interpretation fills a primary resource preservation role by facilitating public participation in the stewardship of park resources. Interpreters convey principal resource messages to the public and help the public understand its relationship to and impact on resources, thus encouraging them to develop personalized, proactive stewardship ethics.[21]

For example, visitor education at parks like Yellowstone and Yosemite is a component of bear management efforts. Public information dissemination helps reduce conflicts between people and bears by raising visitor awareness of how to store and dispose of food properly, how to camp in bear country, and why park bears should never be fed by visitors. In another example at Petrified Forest National Park, interpretive services have been credited for a 50% decrease in petrified wood theft.[22]

3.3.4 Science in Interpretation

One of the fundamental goals of NPS interpretation is to present accurate information in such a way that people will begin to understand and appreciate the significance of the parks and their resources.[23] Good interpretation depends on in-depth resource knowledge as well as knowledge of the audience. The quality of information used for interpretive services depends on the quality of the available scientific information about park resources.

Interpreters must use accurate information when developing interpretive material. They must be knowledgeable about the condition of the park and its resources. Accurate information about resources is essential so that interpretation can strive to provide visitors with the "meaning behind the message" when presenting programs, facilities, exhibits, and publications.

NPS interpretive staff inform and educate visitors about a widening range of natural resource conservation and management issues, requiring a clear and accurate understanding of complex ecosystem relationships discovered through scientific research (*see also* Section 3.3.3).

As individual parks evaluate their interpretive services and plan for the future, they may find that their interpretive services could be made more effective with improved accuracy. For example, Mount Rainier National Park recently reported that much of its interpretive media information was outdated. Some was even inaccurate, in light of newer scientific research.[24]

3.4 Social Resources: The Research Community

The social resources described below include (1) members of the scientific research community who have and will continue to desire access to park specimens and (2) park managers who administer research in parks as well as those who would administer any benefits-sharing.

There are two major categories of individuals and supporting institutions within the research community who conduct scientific research involving research specimens originally acquired through an NPS research permit. They are:

(1) Researchers to whom NPS Scientific Research and Collecting Permits (hereafter "research permits") have been issued directly, and

(2) Researchers, termed "third party researchers," who have obtained specimens from permitted researchers, non-permitted researchers, or other third-party entities such as culture collections.

Although any researcher might unexpectedly make a discovery with potential for commercial development, all known past, present, and proposed commercial uses of research results involving the study of NPS specimens involved biological specimens (*see* Chapter 1, Section 1.2.4). Accordingly, the researchers who discover or seek to discover useful scientific information from study of biological research specimens would be those most likely to be affected by the alternatives in this DEIS. These researchers are sometimes called "bioprospectors," and are described in detail later in this chapter (*see* Section 3.5.3).

3.4.1 Researchers with NPS Research Permits

Thousands of researchers work on park-related studies every year under the authority of an NPS research permit. An NPS review of research permits issued in 2001 describing the number and variety of researchers determined that most researchers are independent of the NPS and that most research is biological, usually including study of research specimens.

In 2001, the NPS authorized at least 4,632 scientists, from all 50 states and 12 foreign countries, to conduct more than 2,150 studies in national parks.[25] Fifty-two percent of all national parks issued research permits in 2001. The average paperwork burden to each researcher for participation in the NPS Research Permit and Reporting System is approximately 1.6 hours.[26] Authorized research projects were funded by many sources, including institutions such as the National Science Foundation as well as joint corporate and/or university-sponsored consortia. Researchers receiving NPS research permits in 2001 came from both private and public scientific entities such as academic institutions, government institutions, and corporations (non-profit and for-profit), including 635 different institutions, of which 3% appeared to be an incorporated entity other than an educational institution or museum. Seventy-six percent of all 2001 NPS Investigator's Annual Reports (IARs) concerned studies in the biological sciences, and 60% of all 2001 NPS research permits authorized the collection of biological material as research specimens.

Any qualified researcher is eligible to obtain a Scientific Research and Collecting Permit in

accordance with NPS regulations and guidelines (*see* Chapter 1, Section 1.2.3).[27] All permitted researchers are subject to the same standards of the NPS research permitting system. Currently, researchers can qualify for NPS research permits regardless of whether or not the research might lead to commercially valuable discoveries.[28] The NPS has not historically prohibited researchers from developing any valuable inventions or other scientific discoveries for any lawful purpose.[29]

Rules for research

Scientific research and specimen collection activities in national parks are governed by NPS regulations, and all research permit applications are evaluated under NEPA (see Chapter 1, Section 1.2.3). All researchers who obtain research permits to perform research in the NPS—whether from private or public research entities—are subject to the same laws, regulations, policies, and guidelines.

3.4.1.1 Research reporting

While a research permit is in effect, researchers are required to submit IARs to the NPS; these are available to the public, as well as to NPS personnel.[30] IARs include summary descriptions and explanations of researchers' scientific objectives and findings. The findings presented in IARs average fewer than 200 words in length and serve to prompt interested park managers, park interpreters, other researchers, and members of the public to contact the author for more details.[31] In addition, as part of determining whether or not to issue a permit, park research coordinators analyze study proposals to determine whether copies of field notes, databases, maps, photos, and/or other materials should also be required or requested as a condition of the NPS research permit.[32] After research has concluded, researchers are requested to provide the park with copies of all published material resulting from their park-related research activities.[33] These published works are the most common form of scientific information that parks gain from research results.

3.4.2 Third-Party Researchers

Third-party researchers are those who have obtained research specimens from permitted researchers, non-permitted researchers, or other third-party entities such as culture collections. For example, third-party recipients of microbial research specimens (including descendants or derivatives of those specimens) are commonly either culture collections (where living descendants of the original research specimens are commonly stored, propagated, and made available to other researchers) or colleagues of the original NPS permittee who obtain their transfers directly from the permittee. In turn, these recipients commonly transfer the research specimens (including descendants or derivatives of those specimens) to additional researchers.

Before 2001, NPS research permit conditions stated that "The NPS reserves the right to designate the repositories of all specimens removed from the park and to approve or restrict reassignment of specimens from one repository to another." In 2001, a provision was added to the General Conditions of NPS research permits prohibiting third-party transfer of research specimens without prior authorization obtained from the NPS.[34] However,

no systematic way has been established to conduct, manage, or report on all of these authorizations, so there is no centralized, accessible record of the occurrence of all third-party transfers.[35]

3.4.3 Research That Could Result in Commercial Application

3.4.3.1 Bioprospecting

Every research project identified by the NPS that involved study of NPS research specimens and has or could have commercial applications for research results has been in the field of biology (*see* Chapter 1, Section 1.2.4). The search for potentially useful discoveries from biological resources existing in nature is not new, but in the early 1990s, this type of research activity was popularly described by a new term: "biodiversity prospecting," or sometimes simply "bioprospecting."[36] However, the terms "biodiversity prospecting" and "bioprospecting" have no legal significance or single, universally-accepted definition (*see* box, Definitions for "Bioprospecting").

This DEIS uses the term "bioprospecting" to describe biological research that could result in a discovery with some commercial application. Bioprospecting research can be targeted at some specific goal or can be a matter of unexpected serendipity. The main difference between bioprospecting and other types of biological research is its objective to search for still-undiscovered attributes of biological specimens that could have some potentially useful and, therefore, valuable applications.

Definitions for "bioprospecting"

The terms "biodiversity prospecting" or "bioprospecting" have no legal significance or single, universally-accepted definition. For example, in 1993, the World Resources Institute defined "bioprospecting" to mean "the exploration of biodiversity for commercially valuable genetic and biochemical resources."[37] In 1997, one of the directors of Costa Rica's National Biodiversity Institute defined the term to mean "the systematic search for, and development of, new sources of chemical compounds, genes, micro- and macro-organisms, and other valuable natural products for their potential use in agricultural and pharmaceutical industries."[38] The government of New Zealand recently defined the term to mean "the examination of biological resources (e.g., plants, animals, and microorganisms) for features that may be of value for commercial development."[39] The term is not defined by, and does not appear in the United Nations Convention on Biological Diversity.

In some places where the term "prospecting" has negative connotations associated with extractive consumptive industries such as mining, the term has been revised. In Australia, the term "biodiscovery" has been used to describe essentially the same types of biological research activities described elsewhere as "bioprospecting."[40]

While also not appearing in any statute or regulation governing NPS management of national parks, the terms "bioprospecting" and "biodiscovery" do describe many of the types of biological research activities that have occurred involving the study of NPS biological research specimens. For example, studies of chemical compounds, genes, enzymes, and other proteins isolated from NPS research specimens have already resulted in the discovery and development of several applications with potential commercial value (*see* Chapter 1, Section 1.2.4).

The impact analysis in Chapter 4 is informed by common stages in the research and development of a bioprospecting discovery as described below. The stage of research during which an NPS specimen might be collected and studied is the discovery, or first stage of research. The most "valuable" period in bioprospecting research in terms both of usefulness of the discovery to society and potential profitability of the discovery for the developer occurs long after the discovery stage of bioprospecting research.

Bioprospecting research is sometimes, but not always, targeted for a specific use; researchers sometimes have a specific end in mind that involves the search for biological material likely to lead to a particular category of discovery. This type of research has been described as a process that combines "logic with serendipity."[41]

Following the initial discovery of a potentially useful research result, this process also sometimes includes additional "downstream" research, evaluation, and development activities involving the following steps:

- *Discovery*—collecting material, screening for potentially useful properties, isolating and purifying new and active biochemicals and compounds, and/or describing new chemical, molecular, genetic, or other elements;
- *Protection of intellectual property*—securing legal protection of new structures and/or specific types of bioactivity or new methods that utilize bioactivity that qualify under applicable intellectual property rights laws;
- *Product development*—modifying biochemical structures to improve their efficacy, and/or conducting clinical and/or field trials to demonstrate and compare the effectiveness and safety of the product with others currently on the market;
- *Manufacturing*—developing techniques for larger-scale industrial production of biochemicals (e.g., by total laboratory techniques or purification from cultivated biological material); and
- *Marketing*—introducing/distributing a final product in the market.[42]

The greatest benefit from the initial discovery is developed at the subsequent stages of the research process.[43] However, income or other benefits are not realized from every bioprospecting research project. For example, pharmaceutical research and development has been described as "a series of lotteries that require substantial expenditures and yield uncertain returns a decade or more in the future."[44] In general, while some can be expected to generate very high returns, most investments in bioprospecting research will not return as much as other "investments."[45]

3.4.3.2 Bioprospectors

Researchers who perform bioprospecting research have been divided into three categories for impact analysis:

- Researchers who have identified an imminent commercial application for their research results and have informed the NPS about such use are termed "**declared bioprospectors**."
- Researchers who unexpectedly discover some potential commercial application for their research results are termed "**inadvertent bioprospectors**." When inadvertent

bioprospectors recognize a commercial use for their research results and inform the NPS, they are reclassified as declared bioprospectors.

- Researchers in fields known to be particularly likely for commercial application but who consider their research to be strictly "basic research," having no clear route for developing their research into commercial products unless and until they actually discover some valuable research result, are termed "**undeclared bioprospectors**." When undeclared bioprospectors recognize a commercial use for their research results and inform the NPS, they are reclassified as declared bioprospectors.

This section discusses each category of bioprospector used for impact analysis: declared bioprospectors, inadvertent bioprospectors, and undeclared bioprospectors.

Declared bioprospectors

Some scientists have informed or acknowledged to the NPS that their research results could be used for some commercial purpose. This information was typically supplied incidentally to filing a research permit application or an Investigator's Annual Report.[46] These scientists (all biologists) can be described as "declared bioprospectors."

In 2001, 12 research projects involving 23 researchers (0.5% of all researchers named in NPS research permits servicewide) provided the NPS with information that indicated that their research results could possibly have commercial uses.[47] In addition, one researcher described a serendipitous bioprospecting discovery made that year, but requested that it be kept confidential while the researcher decided whether to pursue development of the discovery.

Table 3.4.3.2. Bioprospectors in NPS units, 2001

Total researchers named in NPS Scientific Research and Collecting Permits	4,568
Declared bioprospectors	23
Inadvertent bioprospector described a discovery, requested confidentiality, and is now also considered to be a declared bioprospector	1
Total number of bioprospectors known to the NPS	24
Percentage of independent researchers who were declared bioprospectors	0.53%
Number of research projects conducted by declared bioprospectors	12
Number of parks involved	8

Table 3.4.3.2. Less than 1% of researchers holding active NPS research permits were declared bioprospectors in 2001.

The small number of declared bioprospectors in the NPS is also illustrated by information collected by Yellowstone National Park. Because 43 of the 45 patents known to be related to study of NPS research specimens involved specimens first collected at Yellowstone, declared bioprospectors at Yellowstone could be expected to represent most of the declared bioprospectors in the NPS (*see* Chapter 1, Section 1.2.4). In 1998, Yellowstone National Park asked 245 researchers who had held Yellowstone research permits during the previous

several years to clarify whether their research results might have some possible commercial application. Of 169 respondents, only six reported that they expected a commercial application in the foreseeable future.

Figure 3.4.3.2. Declared Bioprospectors in NPS Units, 2001

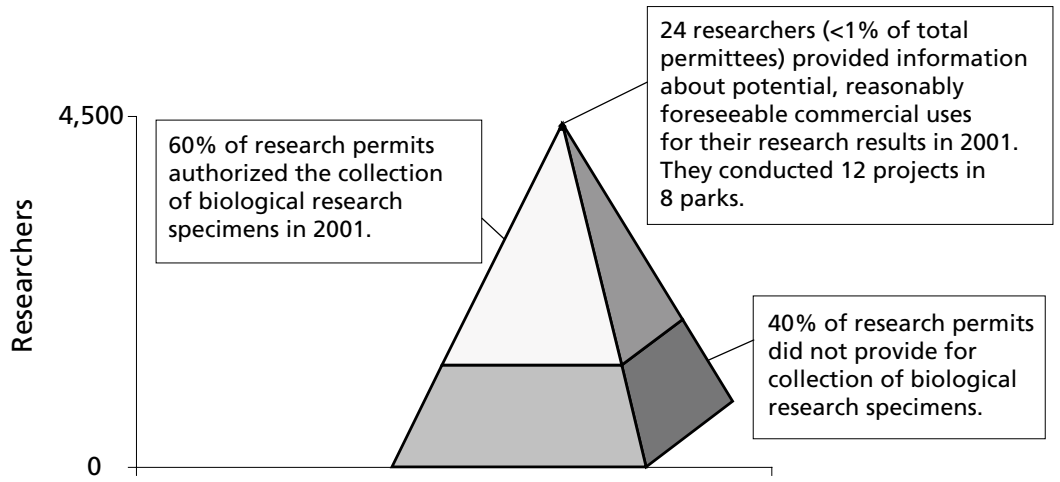

Figure 3.4.3.2. Less than 1% of all independent researchers performing research in NPS units were declared bioprospectors in 2001.

There are several reasons why the number of declared bioprospectors studying national park specimens is so small. First, because the term "bioprospector" lacks any universally agreed-upon definition, researchers do not necessarily think of themselves as "bioprospectors," even when their research activities are sufficiently directed toward the discovery of some new, useful application as to be fairly described as "bioprospecting." Second, the term "commercial use" also has not been defined by the NPS, and therefore may be interpreted differently by different researchers (resulting in different understandings about what it means to be a "bioprospector"). Third, the NPS has not had any voluntary or mandatory way for scientists to systematically identify themselves as researchers who could be using biological material originally sourced from a U.S. national park for research purposes with potential commercially valuable applications. Fourth, premature disclosure of research-related information can disqualify a researcher from applying for and obtaining certain types of intellectual property protection. Finally, many researchers who have developed patentable inventions based on discoveries resulting from research involving NPS biological material obtained the research specimens from third parties (such as culture collections), rather than directly from a national park. The most prominent example of this is *Thermus aquaticus*, collected from Yellowstone and acquired from a culture collection by the Cetus Corporation,

Example: declared bioprospector

Researchers from the Diversa Corporation have consistently informed the NPS that their research activities involving microorganisms collected at Yellowstone could lead to new discoveries with some possible commercial applications.

which developed the polymerase chain reaction (PCR) process using Taq polymerase isolated from the microorganism.

Inadvertent bioprospectors

Some researchers unexpectedly discover some potential commercial application for their research results. In other words, they begin their research activities involving study of NPS biological material for one purpose, but discover something different than what was initially anticipated during the research project. Because of the accidental nature of this type of discovery, virtually any biological researcher could become an "inadvertent bioprospector." When inadvertent bioprospectors recognize a commercial use for their research results and inform the NPS, they are then considered to be declared bioprospectors. In 2001, for example, one researcher made an inadvertent discovery of a potential commercial application for research results and is now considered a declared bioprospector.

Inadvertent discoveries, albeit accidental, can be reasonably expected to result from research activities involving the study of biological material. While such discoveries appear to have occurred most often during the study of newly discovered microorganisms, accidental discoveries that could have some potential commercial value (such as development of a new anti-cancer drug) can occur in any field of biological study.

As with declared bioprospectors, the NPS has been unable to systematically identify researchers who make accidental, potentially valuable discoveries during research activities involving NPS research specimens. Because such a discovery could occur well beyond the one-year time-frame when the researcher is obligated to submit an Investigator's Annual Report, it is not known how many inadvertent bioprospectors have made unexpected discoveries with potential commercially valuable applications.

Example: inadvertent bioprospector

In 1994, an Investigator's Annual Report revealed that research activities originally focused on the ecology of cave-dwelling microorganisms also yielded unexpected discoveries about certain anti-cancer activity isolated from the microorganisms. Thereafter, the researcher shifted the focus of his research emphasis from how the microbes of interest survived in a cave environment to discovery and development of potential new cancer-fighting compounds.[48]

Undeclared bioprospectors

There are some scientists in fields known to be particularly likely for commercial application who consider their studies to be strictly "basic research," because they have no intention of conducting research for the purpose of developing commercial products unless and until they actually discover some valuable research result. Such researchers can be characterized as "undeclared bioprospectors," because their research activities are conducted in fields where there is widely acknowledged interest in potential applications that have some foreseeable commercial purpose and value.

Undeclared bioprospectors are distinguishable from inadvertent bioprospectors because

Example: undeclared bioprospector

A researcher who studies the biochemical strategies used by microbes to survive in toxic environments could be reasonably expected to have a chance of discovering new techniques for bioremediation of toxic industrial waste. The study of biological research specimens that thrive in many different types of extreme environments ("extremophiles") sometimes found in national parks has been a particularly rich field for discoveries with potential commercial applications.[50]

their research activities are in fields known to produce reasonably foreseeable research results with potentially valuable commercial applications. In other words, the research focus of undeclared bioprospectors is in fields of research where the likelihood of discovering a novel bioactive compound with some potential commercial utility is not entirely speculative or serendipitous. Additionally, undeclared bioprospectors differ from declared bioprospectors in that they do not consider their own research activities to have any potential for commercial development until there has been an actual discovery with some demonstrated commercial application.[49] When undeclared bioprospectors recognize a commercial use for their research results and inform the NPS, they are reclassified as declared bioprospectors.

Studies involving some types of research specimens found in national parks may be more likely to generate research results with some potential or real commercial value than research involving other types of specimens. For example, all of the known patents awarded on inventions that resulted at least in part from research involving NPS specimens involved microorganisms, and most were discovered in extreme environments (mainly in thermal areas at Yellowstone National Park).

Approximately 80 researchers with NPS research permits have been identified by park staff as undeclared bioprospectors since about 1990, regardless of whether the researchers themselves would have agreed. Approximately 10 additional undeclared bioprospectors had some amount of contact with park personnel, but either did not apply for or were discouraged from applying for an NPS research permit (*see* Chapter 1, Section 1.2.4). No reliable predictions can be made about which, if any, undeclared bioprospectors might actually make a discovery with potential commercial application.[51]

Types of bioprospectors

Declared bioprospectors—Researchers who provide information to the NPS that their research results could have potential, reasonably foreseeable commercial uses.

Inadvertent bioprospectors—Researchers who accidentally make discoveries having some valuable commercial application. When inadvertent bioprospectors recognize a commercial use for their research results and inform the NPS, they are reclassified as declared bioprospectors.

Undeclared bioprospectors—Researchers who study specific topics with recognized bioprospecting potential but who have not provided information to the NPS about potential, reasonably foreseeable commercial uses for their research results, or who have not identified a commercial use for their research results. When undeclared bioprospectors recognize a commercial use for their research results and inform the NPS, they are reclassified as declared bioprospectors.

3.5 Social Resources: NPS Administrative Operations

Section 3.5 reviews NPS administration of agreements and research permits, both of which could be affected by the alternatives. Although any park could be affected by the alternatives, parks that are most likely to be affected are Yellowstone National Park and other parks currently administering research permits. Chapter 4 analyzes the impact of the alternatives by comparing the administrative effort required to implement the alternatives with the administrative resources currently available in parks.

3.5.1 Administration of NPS Agreements

The National Park Service is authorized to enter into different types of agreements with other agencies, organizations, and individuals, including but not limited to the use of cooperative agreements to conduct multi-disciplinary research.[52] These agreements establish formal relationships that allow the NPS to accomplish its mission more efficiently and economically.

The NPS uses agreements to manage activities and relationships with other federal agencies, state and local governments, non-profit and for-profit organizations, corporations, partnerships, and individuals.[53] The director of the NPS has instructed parks to actively seek opportunities to efficiently and economically accomplish the NPS mission by entering into advantageous relationships with federal and non-federal entities.[54]

The procedures for entering into, reviewing, and terminating agreements are well established.[55] Laws and regulations prescribe the manner or conditions under which agreements may be implemented. NPS managers also have substantial latitude in negotiating and entering into different types of agreements.[56]

The NPS regularly enters into agreements for collaborative research projects that advance knowledge about park resources. By law, management of NPS units must be enhanced by the availability and utilization of a broad program of the highest quality science and information.[57]

As the National Park System Advisory Board reported in *Rethinking the National Parks for the 21st Century,* "A sophisticated knowledge of resources and their condition is essential. The Service must gain this knowledge through extensive collaboration with other agencies and academia, and its findings must be communicated to the public." To effectively undertake the

Programs that bring NPS personnel and scientists together

As of November 2005, there were 12 federal agencies, 160 universities and colleges, and 39 other partners involved in interagency Cooperative Ecosystem Studies Units.[59] In 2001, the NPS inaugurated a new network of 13 Research Learning Centers where scientists, park managers, and the public come together to advance and share learning about park natural resources.[60] In addition, the NPS has a strong relationship with the U.S. Geological Survey on subjects from water quality partnerships to volcano observatories.

dual responsibilities of "parks for science" and "science for parks," NPS personnel conduct cooperative research with federal and non-federal public and private agencies, organizations, individuals, and other entities for the purpose of increasing scientific understanding of NPS natural resources.[58]

3.5.2 Administration of NPS Scientific Research and Collecting Permits

NPS research permits are administered by individual parks through the servicewide NPS Research Permit and Reporting System. The NPS estimates that reviewing and processing application materials and annual reports; conducting environmental reviews and field inspections as needed; and performing necessary typing, photocopying, recordkeeping, mailing, and other standard office activities regarding applications for research permits requires an average of 8.5 person-days per permit.[61]

Alternatives A and B propose no changes to this system. However, during scoping, some comments indicated that the public is concerned that if a potential benefits package were considered as part of a research proposal, parks might be inclined to issue or deny permits based on a new, and to many people, unacceptable criterion. In response, Alternative B includes mitigating measures to ensure that evaluation of research permit applications is not influenced by any benefits-sharing considerations (*see* Chapter 2, Section 2.6).

Alternative C adds a new criterion for approval of a research permit application: the prohibition of research specimen collection for any commercially related purpose. Chapter 4 analyzes the impact of adding this new prohibition.

Since 1992, more than two-thirds of all park units have issued research permits. However, not all parks receive research permit applications or authorize research projects every year (*see* Chapter 1, Section 1.2.3).

The General Conditions of NPS research permits prohibit third-party transfer of research specimens without prior authorization from the NPS.[62] However, no systematic way has been established to conduct, manage, or report on all of these authorizations. Chapter 4 analyzes the impact of standardizing the procedure for transferring research specimens that are ultimately consumed in analysis, which would be an addition to the current system designed to track specimens suitable for permanent museum retention.

3.5.3 Park Units Most Likely to be Affected by Alternative B (Implement Benefits-Sharing)

Agreements and research permits are usually administered by individual park units. Because research could be permitted at any unit in the National Park System, any park unit could be involved in benefits-sharing. The NPS cannot know precisely which research projects would be most likely to result in valuable commercial applications, nor in which parks those projects might occur. Based on past history, some park units are more likely to participate in Alternative B's benefits-sharing program than others.

Because the majority (96%) of the known patents granted for research results involving study of NPS research specimens originally collected from NPS units involve biological specimens originating in Yellowstone, Yellowstone National Park would likely be the first park to participate in a benefits-sharing program if Alternative B were implemented. Additionally, the Yellowstone–Diversa CRADA would be amended to conform to the standardized CRADA in Alternative B (*see* Appendix A). In 2001, six additional researchers provided Yellowstone with information that indicated that their research results could possibly have commercial uses. Accordingly, Yellowstone could expect to enter into additional benefits-sharing agreements if Alternative B were implemented.

Other parks have identified researchers whose research activities could reasonably be expected to result in some valuable discoveries with potential commercial applications. In 2001, seven additional parks, or 1.8% of all park units, received reports about potential commercial uses for research results from projects undertaken through NPS research permits. Since 1990, 30 parks have either issued a research permit, received a research permit application, or fielded an inquiry about a possible research proposal from researchers considered to be bioprospectors. As 270 NPS units have issued research permits, and at least 30 have evidence of bioprospecting interest, the number of parks that could be affected by Alternative B could be between 30 and 270.

Finally, all park units are authorized to issue research permits allowing the collection of research specimens for scientific purposes. If the study of those specimens resulted in discoveries or inventions that could have a commercial application, then any park could participate in benefits-sharing under Alternative B. Any park that receives a research permit application would be affected by Alternative C's new criterion for permit issuance (the prohibition of research specimen collection for any commercially related purpose).

In short, Alternatives B and C would affect NPS administrative operations at Yellowstone National Park as well as other parks, especially those that are already aware of current or potential bioprospectors (30 parks) and those that have already hosted independent research activities (270 parks).

3.5.4 Existing Administrative Resources

Thirty-two of the 44 park Business Plans previously described include information about existing administrative resources.[63] This information is presented in terms of available "full-time equivalents" (FTE); each FTE is the equivalent of one full-time employee and, in this DEIS, represents the amount of work that can be performed by one full-time employee in one year. The Business Plans identify the amount of administrative work that can be accomplished by existing employees as FTE, regardless of how many employees may perform such work on a full- or part-time basis. The number of available administrative FTE in those 32 parks ranges from five at White Sands National Monument to 109 at Yellowstone National Park. The subset of these FTE that responds to research permit applications similarly varies greatly from a low of less than 0.2 FTE to a high of 2.0 FTE.

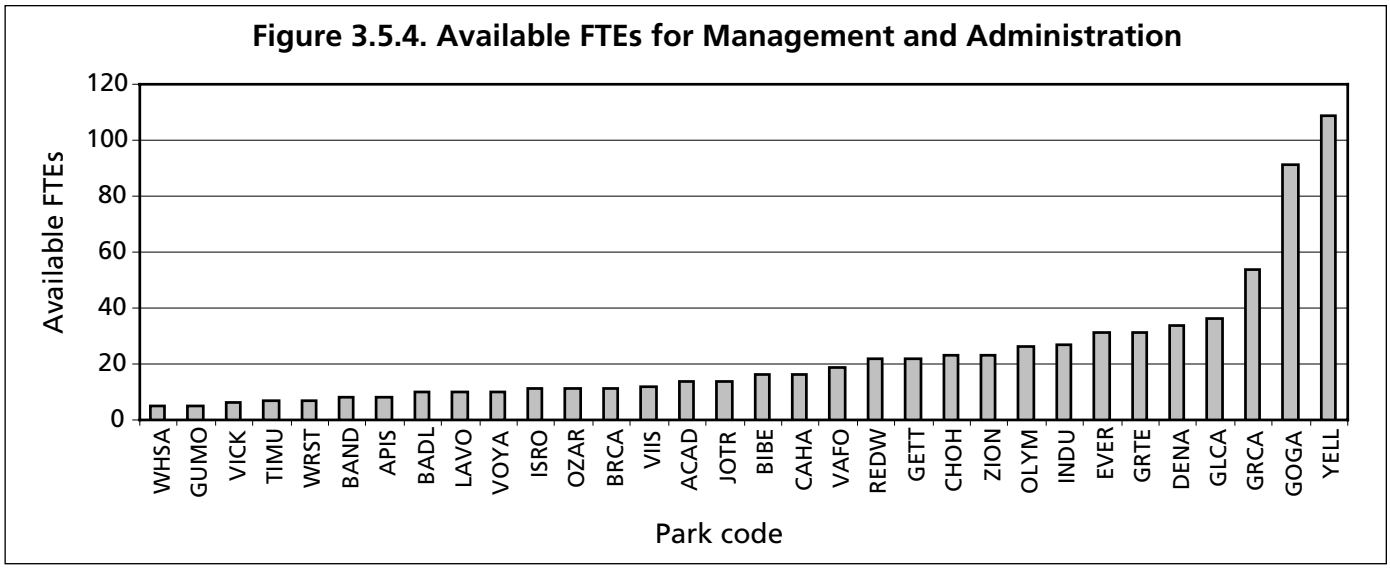

Figure 3.5.4. The number of available administrative FTEs per park varies considerably.

Notes

Section 3.2 Natural Resource Management

[1] *See, e.g.,* National Research Council, *Science and the National Parks* (Washington, D.C.: National Academy Press, 1992) *and* R. W. Sellars, *Preserving Nature in the National Parks: A History* (New Haven: Yale University Press, 1997).

[2] National Park Service, *National Leadership Council Journal* (April 2001).

[3] Chapter 4 analyzes the potential impacts of the alternatives by describing how the alternatives might affect the quality of park research as it relates to park resource management.

[4] Other examples include much of the bird life that nests and rears young in the parks, which is subject to varying environmental stresses in Central and South America.

[5] Council on Environmental Quality (CEQ), *Incorporating Biodiversity Considerations into Environmental Impact Analysis Under the National Environmental Policy Act* (Washington, D.C.: CEQ, 1993).

[6] National Park Service, *National Park Service Management Policies 2001,* Chapter Four: "Natural Resource Management," Section 4.4.1 (Washington, D.C.: U.S. Department of the Interior, 2000).

[7] *Ibid.,* Section 4.0.

[8] National Park Service, *Natural Resource Challenge in Alaska* (March 2002).

[9] National Park Service, *Northeast Region Natural Resource Challenge Annual Report, 2002.*

[10] National Park Service, *Funding the Natural Resource Challenge: A Report to Congress, FY 2001,* available online at <http://www.nature.nps.gov/challenge/congress/congressreport2001.pdf>, last accessed March 20, 2006.

[11] National Park Service, *Management Policies 2001,* Section 4.2 "Studies and Collecting."

[12] The consortium is led by the Kendall Foundation and includes the Vira I. Heinz Foundation, the Walter and Elise Haas Fund, the Compton Foundation, Inc., the Roy A. Hunt Foundation, the National Park Foundation, the David and Lucile Packard Foundation, and the William and Flora Hewlett Foundation.

[13] In 1999, PricewaterhouseCoopers, a private consulting firm, performed an independent analysis of the BPI process, program, and products. Their results provided clear support for the process, indicating that the project could establish a template for business planning in government agencies.

[14] National Park Service, *Natural Resource Challenge: the National Park Service's Action Plan for Preserving Natural Resources* (Washington, D.C.: National Park Service, 1999), *and* National Park Service, *Funding the Natural Resource Challenge.*

[15] The Inventory and Monitoring initiative is a program designed to gather information about park resources and develop techniques for monitoring the ecological communities in the National Park System. *See* National Park Service, *Natural Resource Challenge: the National Park Service's Action Plan for Preserving Natural Resources, and* G. Williams, Inventory and Prototype Monitoring of Natural Resources in Selected National Park System Units 1999–2000, available online at <http://www.nature.nps.gov/

publications/TR2001-1/TitlePage.htm>, last accessed March 14, 2006.

[16] Although Chapter 4 compares potential monetary benefits to Natural Resource Challenge funding, all such benefits might not be usable by the same programs funded by the NRC.

Section 3.3 Visitor Experience and Enjoyment

[17] National Park Service, *NPS Servicewide Interpretive Report FY200*4, "Visitor Contacts," on file at the Interpretation/Education Division, Office of Partnerships, Interpretation and Education, Volunteers, and Outdoor Recreation, NPS Washington Area Service Office.

[18] The most recent NPS website data is for FY2002. C. Mayo, NPS Program Director, Interpretation and Education, personal communication to A. Deutch, October 19, 2005.

[19] M. Gillett, "The Role of Interpretation in Park Operations," *in Interpretive Skills Lesson Plans,* Module 101: **F**ulfilling the NPS Mission: The Process of Interpretation of the NPS Interpretive Development Program (1992) (*see* <http://www.nps.gov/idp/interp>, last accessed March 14, 2006).

[20] K. McCurdy, "Yosemite Wild Bear Project Update," *in American Park Network Guide to Yosemite National Park* (New York: APN Media, LLC, 2001); S. C.Thompson and K. McCurdy, "Black bear Management in Yosemite National Park: More a People Management Problem, pages 105–114 *in* J. Auger and H. L. Black, eds., *Proceedings of the Fifth Western Black Bear Workshop: Human–Black Bear Interactions* (Provo: Brigham Young University Press, 1995); *and* C. J. Widner, "Reducing Theft of Petrified Wood at Petrified Forest National Park," *Journal of Interpretation Research* 5(1):1–18.

[21] National Park Service, *Interpretive Development Program,* available online at <http://www.nps.gov/idp/interp>, last accessed March 14, 2006.

[22] Widner, "Reducing Theft of Petrified Wood at Petrified Forest National Park."

[23] National Park Service, *Management Policies 2001,* Chapter 7.

[24] Mount Rainier National Park, *Long-range Interpretive Plan* (Longmire, Wash.: Mount Rainier National Park, 2000).

Section 3.4 Social Resources: The Research Community

[25] Unless otherwise attributed, figures provided in this paragraph derive from the analysis of 2001 Research Permit Reporting System (RPRS) data on file at Yellowstone National Park. *See also* <http://science.nature.nps.gov/research/ac/ResearchIndex>, last accessed March 14, 2006. Note that co-investigators and research assistants may also be named in a permit at the Principal Investigator's and the park's discretion. Therefore, in the analysis of the number of scientists permitted to research within NPS, it follows that in a number of instances the named investigators supervised additional field assistants, graduate students, or other students, but no data exists regarding these additional members of the research teams.

[26] 69 *Federal Register* 31402-31403.

[27] The RPRS application procedures and requirements for Scientific Research and Collecting Permits state: "Any individual may apply if he/she has qualifications and experience to conduct scientific studies or represents a reputable scientific or educational institution or a federal, tribal, or state agency" (available online at <http://science.nature.nps.gov/research/ac/ResearchIndex>, last accessed March 14, 2006).

[28] The RPRS application procedures and requirements for Scientific Research and Collecting Permits state: "Separate agreements between the investigator and NPS are required when proposed studies or collected specimens are intended to support commercial research activities" (available online at <http://science.nature.nps.gov/research/ac/ResearchIndex>, last accessed March 14, 2006). This is not currently enforced (Department of the Interior, Office of the Solicitor, "Memo to DOI Chief of Staff, Assistant Secretaries, and Heads of Bureaus and Offices: Research Activities on Lands Managed by the Department that Have Potential Bioprospecting Implications," September 10, 1998. On file at Yellowstone National Park, Wyoming).

[29] This distinction and regulatory approach have been upheld on judicial review. *See Edmonds Institute, et al. v. Babbitt, et al.,* 93 F. Supp. 2d 63, 71–72 (DDC 2000), "The court finds that the Park Service reasonably determined that the Yellowstone–Diversa CRADA does not involve the "sale or commercial use" of park resources within the meaning of [36 CFR 2.1]. . . . [T]he Park Service determined that there was a critical distinction between researchers profiting from the sale of the actual specimens themselves, which is prohibited by [36 CFR 2.1], and profiting from a future development based on scientific discoveries resulting from research on those resources, which is permitted. . . . The CRADA, in turn, accords with the regulations because any 'commercial use' flowing from such research is limited to applications or products generated from the scientific study of the resources, not the resources themselves."

[30] National Park Service, "NPS Scientific Research and Collecting Permit General Conditions," available online at <http://science.nature.nps.gov/research/ac/ResearchIndex>, last accessed March 14, 2006.

[31] Analysis of 2001 RPRS data, on file at Yellowstone National Park.

[32] "RPRS Application Procedures and Requirements for Scientific Research and Collecting Permits,"

available online at <http://science.nature.nps.gov/research>, last accessed March 14, 2006.

[33] *Ibid*.

[34] The standardized General Conditions of NPS research permits read, in part, "The sale of collected research specimens or other unauthorized transfers to third parties is prohibited" (available online at <http://science.nature.nps.gov/research/ac/ResearchIndex>, last accessed March 14, 2006).

[35] Transfer of permanently retained specimens is managed by NPS museum specimen loan procedures. However, such procedures apply only to permanently retained specimens and do not apply to transfers of specimens that are intended to be consumed in analysis.

[36] *See* U.S. Office of Technology, "Technologies to Maintain Biological Diversity," *U.S. Office of Technology Assessment* (March 1987), 4, reporting that crop genetic resources account for approximately 50% of productivity increases and for annual contribution of approximately US$1 billion to U.S. agriculture, and that approximately 25% of the number of prescription drugs in the U.S. are derived from research activities involving plants. One of the first uses of the term was by Dr. Thomas Eisner, Professor of Biology at Cornell University (*see* T. Eisner, "Prospecting for Nature's Chemical Riches," *Issues in Science and Technology* 6(20): 31–34; T. Eisner, "Chemical Prospecting: A Proposal for Action, pages 196–202 *in* F. H. Bormann and S. R. Kellert, eds., *Ecology, Economics, and Ethics: The Broken Circle (*New Haven: Yale University Press, 1992). The term became much more widely used after publication of the book, *Biodiversity Prospecting* (W. Reid et al., *Biodiversity Prospecting* (Washington D.C.: World Resources Institute, 1993).

[37] W. Reid et al., *Biodiversity Prospecting,* 1.

[38] A. Sittenfeld and A. Lovejoy, "Biodiversity Prospecting," *in Our Planet (*Nairobi: U.N. Environment Programme, 1997), 20.

[39] Resources and Networks Branch, Ministry of Economic Development, Government of New Zealand, *Bioprospecting in New Zealand* (2002), 5.

[40] According to the Government of Queensland, Australia, "Biodiscovery means collecting biological resources to identify valuable molecular or genetic information about those biological resources and to utilise that information in the development of bio-products" (Government of Queensland, Australia, "Queensland Biodiscovery Policy Discussion Paper" (May 2002), 31).

[41] Harvard Business School, Case Study No. N1-593-015 (October 23, 1992), 5.

[42] Government of New Zealand, *Bioprospecting in New Zealand,* 5, para. 1.6. *See also* Harvard Business School, Case Study No. N1-593-015, 5 and Exhibit 5 (describing the drug discovery and development process in the U.S.).

[43] *See, e.g.*, K. ten Kate, and S. A. Laird, *The Commercial Use of Biodiversity: Access to Genetic Resources and Benefit-Sharing* (London: Earthscan Publications, Ltd., 2000), 9–10, reporting that the rates of return in pharmaceutical research where companies have developed drugs from raw materials provided by outside parties are lowest at the early research stages (1–6%), higher when preclinical data is available and involved (5–10%), and higher still when efficacy data has been developed that can be used to identify a potential product (10–15%). *See also* Government of New Zealand, *Bioprospecting in New Zealand,* 5, para. 1.1.

[44] A. Artuso, *Drugs of Natural Origin: Economic and Policy Aspects of Discovery, Development, and Marketing* (Binghamton, New York: The Haworth Press, 1997), 21.

[45] *Ibid,* 51 and 64 (". . . the models and analytical techniques presented [by Artuso] can easily be applied to evaluate other natural product R&D programs. . . .").

[46] In occasional cases, researchers acknowledge the use of biological research specimens used in connection with a valuable commercial application in other contexts (such as in patent documents).

[47] Deutch, A., "Analysis of the NPS Research Permit Database for Calendar Year 2001," (2002), on file at Yellowstone National Park.

[48] L. Mallory, "Isolation of Cancer Chemotherapeutic Natural Products from Cave Microorganisms" (NPS Investigator's Annual Report, 1994), available online at <http://science.nature.nps.gov/research/ac/iars/search/iarView?reportId=2698>, last accessed March 14, 2006. This researcher has explained that the application of his initial research results to cancer research occurred only after his initial discovery that the microorganisms under study exuded compounds that interfered with the growth of competing microorganisms.

[49] The results of a survey undertaken in 1998 by Yellowstone illustrated the difficulty of identifying "undeclared bioprospectors." In that survey, some researchers who the park considered to be "bioprospectors" disavowed any intention of making commercially useful discoveries. On file at Yellowstone National Park.

[50] *See, e.g.*, Madigan and Marrs, "Extremophiles," *Scientific American* (April 1997): 82–87.

[51] *See, e.g.,* Artuso, *Drugs of Natural Origin,* 120. It is noted that interpretation of available data on screening programs relating to drug discovery is complicated by no standard definition of such terms as "hit rate," "active compounds," or "drug leads" (*Ibid.,* 34). Additional variation could be expected when applied to other non-pharmaceutical industries. *See also* W. H. Lesser and A. F. Krattiger, "The Complexities of

Negotiating Terms for Germplasm Collection, *Diversity* 10(3), 6.

Section 3.5 Social Resources: NPS Administrative Operations

[52] 16 USC 5933.

[53] National Park Service, *Agreements Handbook,* Chapter 7. (Washington, D.C.: Government Printing Office, 2003).

[54] National Park Service, *NPS Director's Order 20: Agreements* (2003), available online at <http://www.nps.gov/policy/DOrders/DOrder20.html>, last accessed March 15. 2006.

[55] *National Park Service Agreements Handbook,* available online at <http://www.nps.gov/hfc/acquisition/agreements.htm>, last accessed March 15, 2006.

[56] National Park Service, *NPS Director's Order 20: Agreements*.

[57] 16 USC 5932.

[58] *See, e.g.,* National Park Service, *National Leadership Council Journal*, April 2001 and November 2002.

[59] Cooperative Ecosystem Studies Unit briefing statement, November 18, 2005, available online at <http://www.cesu.org/news/briefings.html>, last accessed March 14, 2006.

[60] *See* <http://www.nature.nps.gov/learningcenters/centers.cfm>, last accessed March 20, 2006.

[61] National Park Service, Paperwork Reduction Act submission.

[62] The standardized General Conditions of NPS research permits read, in part, "The sale of collected research specimens or other unauthorized transfers to third parties is prohibited" (available online at <http://science.nature.nps.gov/research/ac/ResearchIndex>, last accessed March 14, 2006).

[63] Most Business Plans prepared in 1999 (the first year of the Initiative) did not include FTE information.